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What is claimed

1. 1. A manipulator for positioning and orienting a test head, comprising:
2 an elongated blade that extends along a central axis from a region outside the test
3 head into an internal region of the test head; and
4 an interface coupling disposed in the internal region of the test head, having a first
5 portion coupled to the elongated blade and a second portion coupled to the test head, the
6 first and second portions being free to rotate with respect to each other in compliance
7 about at least one axis of rotation.
- 1 2. The manipulator of claim 1, wherein interface bearing includes a bearing
2 assembly, the first portion of the interface coupling including a first race of the bearing
3 assembly and the second portion of the interface coupling including a second race of the
4 bearing assembly.
- 1 3. The manipulator of claim 2, wherein the bearing assembly is a spherical bearing,
2 and the first and second races are free to rotate with respect to each other in compliance
3 about all axes of rotation.
- 1 4. The manipulator of claim 3, wherein the first race is an outer race of the spherical
2 bearing and the second race is an inner race of the spherical bearing.
- 1 5. The manipulator of claim 3, further comprising a transition insert disposed in the
2 internal region of the test head and having an opening into which the elongated blade
3 enters, wherein the transition insert is coupled to the test head and fixedly attached to the
4 first and second races of the spherical bearing.
- 1 6. The manipulator of claim 5, further comprising at least one linear coupling
2 oriented in parallel with the central axis and having first and second elongated
3 components, the first component being coupled to the test head and the second
4 component being coupled to the transition insert, the first and second components being
5 movably coupled to each other.
- 1 7. The manipulator of claim 6, further comprising a linear adjustment mechanism,
2 having a first portion coupled to the test head and a second portion coupled to the

3 transition insert, wherein the linear adjustment mechanism is adapted to move the test
4 head along the at least one linear coupling relative to the elongated blade.

1 8. The manipulator of claim 1, further comprising at least one linear coupling
2 oriented in parallel with the central axis and having first and second elongated
3 components, the first component being coupled to the test head and the second
4 component being coupled to the elongated blade, the first and second components being
5 movably coupled to each other.

1 9. The manipulator of claim 8, wherein the first component of each at least one
2 linear coupling includes one of a truck and a rail, and the second component of each at
3 least one linear coupling includes the other of the truck and the rail.

1 10. The manipulator of claim 9, wherein the at least one linear coupling includes two
2 linear couplings disposed on opposing sides of the elongated blade.

1 11. The manipulator of claim 9, wherein the at least one linear coupling comprises
2 one linear coupling, and further comprising an elongated guide, the one linear coupling
3 and the elongated guide being disposed on opposing sides of the elongated blade.

1 12. The manipulator of claim 8, wherein the interface coupling further includes a
2 linear adjustment mechanism, having a first portion coupled to the test head and a second
3 portion coupled to the elongated blade, the linear adjustment mechanism being adapted to
4 move the test head relative to the elongated blade along the at least one linear coupling.

1 13. The manipulator of claim 12, wherein the linear adjustment mechanism includes
2 at least one lead screw, the lead screw engaging a threaded region of the test head and
3 having a termination coupled to the elongated blade.

1 14. The manipulator of claim 12, wherein the linear adjustment mechanism includes
2 at least one lead screw, the lead screw engaging a threaded region of the elongated blade
3 and having a termination coupled to the test head.

1 15. The manipulator of claim 1, further comprising a transition insert disposed in the
2 internal region of the test head and having an opening into which the elongated blade

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3 enters, the transition insert being coupled to the test head and fixedly attached to the first
4 and second portions of the interface coupling.

1 16. The manipulator of claim 15, wherein the interface coupling includes a spherical
2 bearing wherein the first portion of the interface coupling includes an outer race of the
3 spherical bearing and the second portion of the interface coupling includes an inner race
4 of the spherical bearing.

1 17. The manipulator of claim 16, wherein the elongated blade has a hole in which the
2 spherical bearing is disposed, and the transition insert further comprises:

3 left and right plates, disposed on opposing sides of the elongated blade, each
4 having a hole that aligns with the hole in the elongated blade; and
5 a shaft passing through the holes in the left and right plates, though the hole in the
6 elongated blade and engaging the inner race of the spherical bearing.

1 18. The manipulator of claim 17, wherein the transition insert further includes:
2 left and right retainers fixedly attached to the elongated blade on opposing sides of
3 the hole in the elongated blade and engaging the outer race of the spherical bearing.

1 19. A manipulator for positioning and orienting a test head, comprising:
2 a stiffener fixedly attached to the test head and having top, bottom, and back
3 portions;
4 an elongated blade extending along a central axis from a region outside the test
5 head into an internal region of the test head between the top and bottom portions of the
6 stiffener and in front of the back portion of the stiffener; and
7 an interface coupling having a first portion coupled to the elongated blade in the
8 internal region of the test head and a second portion coupled to the stiffener, the first and
9 second portions of the interface coupling being free to rotate with respect to each other in
10 compliance about at least one axis of rotation.

1 20. The manipulator of claim 19, further comprising a transition insert disposed in the
2 internal region of the test head and having an opening into which the elongated blade
3 enters, wherein the transition insert is coupled to the stiffener and fixedly attached to the
4 first and second portions of the interface coupling.

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1 21. The manipulator of claim 20, further comprising at least one linear coupling
2 oriented in parallel with the central axis and having first and second elongated
3 components, the first component being coupled to the stiffener and the second component
4 being coupled to the transition insert, the first and second components being movably
5 coupled to each other.

1 22. The manipulator of claim 21, further comprising a linear adjustment mechanism,
2 having a first portion coupled to the stiffener and a second portion coupled to the
3 transition insert along the at least one linear coupling.

1 23. The manipulator of claim 22, wherein the interface coupling includes a spherical
2 bearing having an outer race coupled to the first portion of the interface coupling and an
3 inner race coupled to the second portion of the interface coupling.

1 24. The manipulator of claim 23, wherein the elongated blade has a hole within which
2 the spherical bearing is disposed, and the transition insert has left and right plates, each
3 having holes, disposed on opposing sides of the elongated blade, the transition insert
4 including:

5 a shaft passing through the holes in the left and right plates, and though the hole in
6 the elongated blade and engaging the inner race of the spherical bearing.

1 25. The manipulator of claim 24, wherein the retaining mechanism further includes:
2 left and right retaining plates disposed on opposing sides of the hole in the
3 elongated blade, each having a hole through which the shaft passes, and being fixedly
4 attached to the elongated blade and to the outer race of the spherical bearing.

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1 30. A method of assembling a test head for use with a manipulator, comprising:
2 providing a stiffener having top, bottom, and back portions, and left and right
3 mounting surfaces;
4 inserting an elongated blade into an internal region between the top and bottom
5 portions of the stiffener and in front of the back portion of the stiffener;
6 attaching the elongated blade to the stiffener; and
7 fastening respective first and second portions of the test head to the left and right
8 mounting surfaces of the stiffener.

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- 1 31. The method of claim 30, wherein the step of attaching the elongated blade to the
2 stiffener includes attaching an outer race of a spherical bearing to the elongated blade and
3 attaching an inner race of the spherical bearing to the stiffener.

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- 1 32. The method of claim 31, further comprising balancing the test head on the
2 spherical bearing by adjusting a distance between the back portion of the stiffener and the
3 elongated blade.